

Sensitization to common indoor allergens and its association with allergic diseases in Thai female high-school students

Prasarnphanich T, Sindhurat S. Sensitization to common indoor allergens and its association with allergic diseases in Thai female high-school students.

Pediatr Allergy Immunol 2005; 16: 402–407. © 2005 Blackwell Munksgaard

Allergic sensitization is generally agreed to be an important risk factor for allergic diseases. It has been demonstrated in most of the children attending allergy clinics in Thailand but has never been studied in Thai general populations. The objectives were (i) to describe the prevalence of sensitization to common indoor allergens in Thai female-high-school students and (ii) to evaluate the association of allergic sensitization to allergic diseases in these students. A cross-sectional analytic study was designed. Seven hundred and six schoolgirls were enrolled during May–June 2002. Written ISAAC questionnaires were completed by the students and skin prick tests were performed in 344 (48.7%) students with a battery of seven common allergens including *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, American cockroach, Cat, *Cladosporium*, *Penicillium*, and *Aspergillus*. Positive test was defined as a mean wheal diameter of at least 3 mm at the 15 min reading. The adjusted odds ratios (OR) and 95% confidence intervals (CI) were obtained from multiple regression analysis for the independent effect of sensitization to each allergen on allergic diseases. A total of 154 (44.8%) students had evidence of allergic sensitization on skin prick tests. The prevalence rates of sensitization to various groups of allergens were as follows; mites 43.0%, cockroach 12.8%, cat 4.1%, and molds 1.2%. The independent effect of allergic sensitization on allergic diseases was observed only in mite sensitization on nose problem (OR = 1.73, CI = 1.07–2.78 for nose problem ever and OR = 1.85, CI = 1.13–3.02 for nose problem in 12 months). The risk of nose problem was also increased with the number of positive reactions. Conclusion: We found that sensitization to the four common allergen groups were weakly associated with the presence of allergic diseases in Thai schoolgirls. This confirms the observation that the development of allergic diseases is not solely attributable to allergic sensitization.

Thanong Prasarnphanich and Sintra Sindhurat

Department of Pediatrics, Prapokklao Hospital, Chantaburi, Thailand

Key words: allergic diseases; atopy; sensitization; skin prick test

Dr Thanong Prasarnphanich, Department of Pediatrics, Prapokklao Hospital, Chantaburi 22000, Thailand

E-mail: cocojatukak@hotmail.com

Accepted 9 May 2005

Background and rationale

There is good evidence over the past three decades that the prevalence of allergic diseases has been increasing in many countries worldwide, particularly childhood (1). In Thailand, over the past decade, the prevalence of childhood allergic diseases in Bangkok increased threefold for asthma and twofold for allergic rhinitis (2, 3). Allergic diseases are the major illness and the most

common cause of school absence among children (4). So, allergic diseases are now a serious health problem and a significant burden, not only in terms of health care costs but also of lost productivity and reduced participation in family life.

Asthma, allergic rhinitis and atopic dermatitis are often termed allergic diseases and are complex disorders attributed by many risk factors. Atopy as the host factor and early exposure to

allergens as the environmental factor are the major risk factors involved in the development of allergic diseases (5, 6). There is some evidence that level of indoor allergen exposure is a risk factor for the development of allergic sensitization in children (7–9). Thus, it has been speculated that exposure to an allergen is the cause of allergic diseases. Some allergic diseases are clearly predominantly atopic such as hay fever or food allergy. However, diseases such as asthma and perennial allergic rhinitis may or may not be atopic. Even in children, when atopy is presumed to be the cause in the majority of children, similar symptoms occur in non-atopic individuals (10). The available epidemiological evidence suggests that the population-based proportion of asthma cases that are attributable to atopy is usually less than one half (11).

The prevalence of positive skin test for common allergens from hospital based studies in Thailand was 74–95% for asthmatic patients (12, 13) and 98% for allergic children (14). The previous studies from USA and Sweden revealed that the prevalence of positive skin test in subjects with no allergic symptoms was 3–50% (15, 16). The information on the relationship of allergic sensitization and risk of allergic manifestations in Thai population is lacking.

We recently studied the prevalence of asthma and allergic diseases using ISAAC questionnaire in Thai school children living at Chantaburi. We found a high prevalence of both asthma and allergic sensitization. In the present paper we evaluate the sensitization to common indoor allergens and its relationship to allergic manifestations at a female high school.

Methods

Population

Seven hundred and six junior-high-school students of Sriyanusorn School, a female high school at Chantaburi, who completed the written ISAAC questionnaire, were invited to participate in the study during May–June 2002. Most of the students were 13–14-year old. Chantaburi is a province situated in the eastern Thailand about 245 km from Bangkok and near the Cambodian border. The weather is hot and humid because of the tropical climate. The main occupation of the people is agriculture and there are few industries.

Study design

The study design is a cross-sectional analytic study. The skin prick tests were done after

written consents from the parents were obtained. The students who had not stopped all antihistamines for at least 2 weeks prior to testing were excluded.

The study was approved by the ethics committee of Prapokklao Hospital Chantaburi.

Questionnaire

The questionnaire was standard ISAAC questionnaire about symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema. The questionnaire was translated into Thai by a panel of pediatric allergists from several academic centers in Thailand.

Allergens

A battery of seven common indoor allergens (Center Laboratories Inc., Port Washington, NY, USA) grouped into four allergen groups was used including (i) dust mites (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*); (ii) cockroach (American cockroach); (iii) cat; (iv) molds (*Cladosporium*, *Aspergillus*, and *Penicillium*). Histamine and normal saline solution were used as positive and negative controls, respectively.

Skin prick test

The skin prick tests were done with ultra-fine lancet. The mean of two perpendicular diameters measured at 15 min was taken to be the size of the reaction. A wheal of 3 mm or greater was regarded as positive in the absence of a reaction to normal saline solution.

Statistical analysis

The chi-square test was used to assess the association between categorical variables and test the univariate association between each allergic diseases and positive skin prick test. Multiple logistic regression analysis was done to demonstrate the adjusted odds ratios (OR) and 95% confidence intervals (CI) for the independent effect of sensitization to each allergen on allergic disease, adjusting for the effect of sensitization to other allergens.

Ethical considerations

Turkeltaub reported the risk of adverse reactions from percutaneous prick puncture allergen skin testing was 0.04% (17). In this study, we prepared the medications and instruments for

basic life support and observed the students for adverse reactions at least half an hour after the tests.

Results

Table 1 shows the information on the positive responses to written questionnaires of 706 students. The cumulative prevalence rates of wheeze ever, nose problem ever and rash ever were 19.0%, 41.9%, and 12.7%, respectively. The period prevalence rates of wheeze, nose problem, and rash in 12 months were 12.6%, 34.0%, and 14.1%, respectively. About 344 (48.7%) students

had skin prick tests done. There was no significant difference in allergic symptoms between those who had skin prick test and those who had not. According to the criteria, 154 (44.8%) of 344 skin prick tested students had positive reactions to one or more allergens. The prevalence rates of sensitization to the four allergen groups were as follows; mites 43%, cockroach 12.8%, cat 4.1%, and molds 1.2%.

Table 2 shows the univariate analysis for the association between each positive skin prick test and allergic diseases. A higher proportion of the students with wheeze and nose problem had evidence of allergic sensitization on skin prick tests than the students without these symptoms, but the difference was statistically significant only for nose problem (OR = 1.87, CI = 1.21–2.89 for nose problem ever OR = 2.04, CI = 1.30–3.21 nose problem in 12 months). Similarly, the students with wheeze and nose problem were more likely to have positive skin prick tests to each allergen than the students without these symptoms, but the significant associations were observed only between cockroach sensitization and wheeze ever (OR = 2.25, CI = 1.13–4.48), between mite sensitization and nose problem ever (OR = 1.82, CI = 1.18–2.82) and between mite sensitization and nose problem in 12 months

Table 1. Prevalences of allergic symptoms

Questionnaire response	Prevalences (%) of symptoms			p Value
	Skin prick test done (n = 344)	Skin prick test not done (n = 362)	Total (n = 706)	
Wheeze ever	71 (20.6)	63 (17.4)	134 (19.0)	0.273
Wheeze in 12 months	50 (14.5)	39 (10.8)	89 (12.6)	0.132
Nose problem ever	139 (40.4)	157 (43.4)	296 (41.9)	0.425
Nose problem in 12 months	117 (34.0)	123 (34.0)	240 (34.0)	0.992
Rash ever	43 (12.5)	47 (13.0)	90 (12.7)	0.847
Rash in 12 months	51 (14.8)	49 (13.5)	100 (14.2)	0.623

Table 2. Positive skin prick tests in students with allergic diseases (univariate analysis)

Sensitization (%)	Wheeze ever		OR	95% CI	Wheeze in 12 months		OR	95% CI
	Yes (n = 71)	No (n = 273)			Yes (n = 50)	No (n = 294)		
Any allergen	37 (52.1)	117 (42.9)	1.45	0.86–2.45	26 (52.0)	128 (43.5)	1.40	0.77–2.56
Mites	35 (49.3)	113 (41.4)	1.37	0.81–2.32	24 (48.0)	124 (42.0)	1.27	0.69–2.31
Cockroach	15 (21.1)	29 (10.6)	2.25*	1.13–4.48	10 (20.0)	34 (11.6)	1.91	0.88–4.17
Cat	3 (4.2)	11 (4.0)	1.05	0.28–3.87	2 (4.0)	12 (4.1)	0.98	0.21–4.51
Molds	2 (2.8)	2 (0.7)	3.93	0.54–28.38	1 (2.0)	3 (1.0)	1.98	0.20–19.42
	Nose problem ever				Nose problem in 12 months			
	Yes (n = 139)	No (n = 205)			Yes (n = 117)	No (n = 227)		
Any allergen	75 (54.0)	79 (38.5)	1.87*	1.21–2.89	66 (56.4)	88 (38.8)	2.04*	1.30–3.21
Mites	72 (51.8)	76 (37.1)	1.82*	1.18–2.82	63 (53.8)	85 (37.4)	1.95*	2.24–3.06
Cockroach	21 (15.1)	23 (11.2)	1.41	0.75–2.66	18 (15.4)	26 (11.5)	1.41	0.74–2.68
Cat	9 (6.5)	5 (2.4)	2.77	0.91–8.45	8 (6.8)	6 (2.6)	2.70	0.91–7.98
Molds	2 (1.4)	2 (1.0)	1.48	0.21–10.64	2 (1.7)	2 (0.9)	1.96	0.27–140.7
	Rash ever				Rash in 12 months			
	Yes (n = 43)	No (n = 301)			Yes (n = 51)	No (n = 293)		
Any allergen	19 (44.2)	135 (44.9)	0.97	0.51–1.85	23 (45.1)	131 (44.7)	1.02	0.56–1.85
Mites	19 (44.2)	129 (42.9)	1.06	0.55–2.00	22 (43.1)	126 (43.0)	1.00	0.55–1.83
Cockroach	4 (9.3)	40 (13.3)	0.67	0.23–1.97	5 (9.8)	39 (13.1)	0.71	0.26–1.89
Cat	3 (7.0)	11 (3.7)	1.98	0.53–7.39	2 (3.9)	12 (4.1)	0.96	0.21–4.40
Molds	0	4 (1.3)	–	–	0	4 (1.4)	–	–

CI, confidence intervals; OR, odds ratio.

*Statistical significance at $\alpha = 0.05$.

Table 3. Adjusted OR and CI for the independent risk of allergic diseases with sensitization to allergens (multiple logistic regression analysis)

	Mites		Cockroach		Cat		Molds	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Wheeze ever	0.91	0.51–1.64	0.45	0.21–0.97	1.44	0.36–5.68	0.27	0.03–2.09
Wheeze in 12 months	0.93	0.48–1.82	0.53	0.22–1.25	1.36	0.28–6.66	0.54	0.50–5.60
Nose problem ever	1.73*	1.07–2.78	0.98	0.49–1.96	2.12	0.67–6.73	0.93	0.12–7.05
Nose problem in 12 months	1.85*	1.13–3.02	0.95	0.47–1.92	2.00	0.65–6.15	1.22	0.16–9.15
Rash ever	1.13	0.56–2.26	0.55	0.17–1.77	2.46	0.60–10.48	–	–
Rash in 12 months	0.89	0.47–1.69	1.45	0.53–4.27	0.90	0.18–4.41	–	–

CI, confidence intervals; OR, odds ratio.

Odds ratios (OR) were adjusted for the effect of sensitization to each allergen other than the one of interest.

*Statistical significance at $\alpha = 0.05$.

Table 4. Number of positive skin prick tests and allergic diseases

Number of positive reactions	Total	Wheeze ever	Nose problem ever*	Rash ever	Wheeze in 12 months	Nose problem in 12 months**	Rash in 12 months
0	190	34 (17.9%)	64 (33.7%)	24 (12.6%)	24 (12.6%)	51 (26.8%)	28 (14.7%)
1	52	9 (17.3%)	21 (40.4%)	8 (15.4%)	7 (13.5%)	20 (38.5%)	9 (17.3%)
2	63	15 (23.8%)	33 (52.4%)	7 (11.1%)	11 (17.5%)	28 (44.4%)	10 (15.9%)
≥3	39	13 (33.3%)	21 (53.8%)	4 (10.3%)	8 (20.5%)	18 (46.2%)	4 (10.3%)

*p Value = 0.017. **p Value = 0.015.

(OR = 1.95, CI = 2.24–3.06). For students with rash, there was no association with allergic sensitization.

The adjusted OR and 95% CI obtained from multiple regression analysis for the independent effect of sensitization to each allergen on allergic disease are shown in Table 3. In the regression model, the effect of sensitization to other allergens was adjusted. The wheeze, nose problem and rash were entered as the dependent variable and the results of skin prick tests to allergens were entered as covariates. The independent effect of sensitization on allergic diseases was observed only in mite sensitization on nose problem (OR = 1.73, CI = 1.07–2.78 for nose problem ever and OR = 1.85, CI = 1.13–3.02 for nose problem in 12 months).

Table 4 shows the number of positive reactions and the risk of allergic diseases. The risk of wheeze and nose problem were increased with the number of positive reactions but there were statistically significant only for nose problem ($p = 0.017$ for nose problem ever and $p = 0.015$ for nose problem in 12 months).

Discussion

Risk factors for allergic diseases may be classified by host factors and environmental factors. Genetic predisposition is the major host factor

and there is good evidence to indicate that allergic diseases are heritable disease. Environmental factors including allergens, tobacco smoke, air pollution, respiratory infections, and diet may influence the susceptibility to the development of allergic diseases in predisposed individuals. Exposure to allergens is an important risk factor for the development of allergic sensitization but the extent to which allergic sensitization accounts for allergic diseases is controversial.

In Thailand, most studies on the relationship of allergic sensitization and allergic manifestations were derived from hospital-based data. The prevalence rates of allergic sensitization in Thai asthmatic patients were about 74–98% (12–14). Our recent study at Prapokklao Hospital also revealed the high prevalence of allergic sensitization in allergic children (88.5%) (18). But this information cannot be concluded how much of allergic disease is attributable to allergic sensitization. In this study we found high prevalence of allergic diseases but the prevalence of the allergic sensitization in allergic students was rather low comparing with the hospital-based data as previously mentioned. The overall prevalence of allergic sensitization in our study was 44.8% and there was non-significant difference between allergic and non-allergic students (48% vs. 42%, respectively). We also found that sensitization to each

allergen was weakly associated with the presence of allergic diseases.

Several studies reported the relationship of allergen exposure, sensitization, and the development of allergic diseases (19–24). A meta-analysis describing the association of asthma and atopy concluded that the proportion of asthma cases that attributable to atopy averaged between 30% and 40% in both adults and children (11). Although these population-based studies suggest an association between the prevalence of atopy and asthma, comparisons across populations or time periods show only weak and inconsistent association between the prevalence of asthma and the prevalence of atopy. The association between allergic sensitization and asthma is age dependent. The majority of children who become sensitized to allergens during the first 3 yr of life develop asthma later in life. The children who become sensitized after the age of 8–10 yr have a risk of developing asthma not much higher than those who were not (25). This age-dependent observation is confirmed by our present study, which found weak association between allergic sensitization and allergic diseases in the students aged 13–14 yr.

In this study we included mites, cockroach, cat and molds in our standard battery because these allergens are the common indoor allergens in Thailand (12–14). Mites and cockroaches are the most common allergens in Thailand reflecting heavy infestation because the hot and humid climate provides the ideal habitat for them. Mites are the most common indoor allergen associated allergic diseases worldwide (26–27). In some areas, mites and cockroaches are uncommon, allergy to domestic animals, particularly cat and dog, is a significant risk factor for allergic diseases. So, with skin prick tests as a screening method for atopy, a number of the common allergens included in the standard battery should be considered carefully.

As previously mentioned, early allergen exposure is a risk factor for the development of allergic sensitization but not for asthma (28). Many other factors may contribute to the expression of asthma and other allergic symptoms later in life (29). Our study confirms that only a small proportion of allergic diseases in older children were attributable to atopy.

Acknowledgments

We are grateful to the invaluable advice of Professor Pakit Vichayanond, Division of Allergy and Immunology, Department of Pediatrics, Faculty of Medicine, Siriraj Hospital, Mahidol University, Thailand. We thank all the students and teachers who participated in this study.

References

- GINA Executive Committee. Burden of asthma. In: LENFANT C, ed. *Global Strategy for Asthma Management and Prevention*: Revised 2002. GINA Workshop report. Washington, DC: NIH Publication No. 02-3659 February, 2002: 11–26.
- BOONARITTIPONG P, TUCHINDA M, BALANGURA K, VISITSUNTORN N, VANAPRAPARA N. Prevalences of allergic diseases in Thai children. *J Pediatr Soc Thai* 1990; 29: 24–32.
- VICHYANOND P, JIRAPONGSANANURUK O, VISITSUNTORN N, TUCHINDA M. Preevalence of asthma, rhinitis, and eczema in children from Bangkok area using the ISAAC questionnaires. *J Med Assoc Thai* 1998; 81: 175–84.
- SCHIER CG, HUNT EP. *Illness among children*. Children's Bureau publication no. 405. Washington, DC: Department of Health Education and Welfare 1963.
- KJELLMANN NIM, CRONER S. Cord blood IgE determination for allergy predictions: a follow-up to seven years of age in 1651 children. *Ann All* 1984; 53: 571–8.
- SCHUTTZ LF. Atopic dermatitis: a genetic-epidemiologic study in a population – based twin sample. *J Am Acad Dermatol* 1993; 28: 719–23.
- WAHN U, LAU S, BERGMANN R, et al. Indoor allergen exposure is a risk factor for sensitization during the first three years of life. *J All Clin Immunol* 1997; 99: 763–9.
- SPORIK R, HOLGATE ST, PLATTS-MILLS TAE, et al. Exposure to house dust mite allergen (Der p 1) and the development of asthma in childhood. A prospective study. *N Eng J Med* 1990; 323: 502–7.
- PEAT JK, LI J. Reversing the trend: reducing the prevalence of asthma. *J All Clin Immunol* 1999; 103: 1–10.
- GERGEN PJ, TURKELTAUB PC. The association of individual allergen reactivity with respiratory disease in a national sample: data from the second National Health and Nutrition Examination Survey, 1976–80 (NHANES-II). *J All Clin Immunol* 1992; 90: 579–88.
- PEARCE N, PEKKANEN J, BEASLEY R. How much asthma is really attributable to atopy? *Thorax* 1999; 54: 268–72.
- KONGPANICHKUL A, VICHAYANOND P, TUCHINDA M. Allergen skin test reactivities among asthmatic Thai. *J Med Assoc Thai* 1997; 80: 69–75.
- PALWATWICHAI A, ROENG-ASWADEJ W, SAENG-ASP-AWIRIYA A, THITIWIWICHIANLERT S, FOENGTHONG R. Prevalence of positive skin test reactions to aeroallergens in Thai asthmatic patients. *RTA Med J* 2000; 53: 21–5.
- NGAMPHAIBOON J, BOONPIRAK B, CHATCHATEE P. Intradermal skin testing in aeroallergic Thai children. *Chula Med J* 1998; 42: 105–13.
- LINBLAD JH, FARR RS. The incidence of positive intradermal reactions and the demonstration of skin sensitizing antibody to extracts of ragweed and dust in humans without history of rhinitis or asthma. *J All* 1961; 32: 392–6.
- NORMAN E, ROSENHALL L, NYSTROM L, et al. Prevalence of positive skin test, allergic asthma and rhinoconjunctivitis in teenagers in northern Sweden. *Allergy* 1994; 49: 808–15.
- TURKELTAUB PC, GERGEN PJ. The risk of adverse reactions from percutaneous prick puncture allergen skin testing, venipuncture, and body measurements: data from the second National Health and Nutrition Examination Survey 1976–80 (NHANESII). *J All Clin Immunol* 1989; 84: 886–90.

18. PHOOMYOTHA K, PRASARNPHANICH T. Study of skin prick test in children with allergic diseases. *J Prapokklao Hosp Clin Med Educ Center* 2003; 1: 5–12.
19. WIERINGA MH, WEYLER JJ, VAN BASTELAER FJ, NELEN VJ, VAN SPRUNDEL MP, VERMEIRE PA. Higher asthma occurrence in an urban than a suburban area: role of house dust mite skin allergy. *Eur Respir J* 1997; 10: 1460–6.
20. BURROWS B, MARTINEZ FD, HALONEN M, BARBEE RA, CLINE MG. Association of asthma with serum IgE levels and skin-test reactivity to allergens. *N Engl J Med* 1989; 320: 271–7. *Clin Exp All* 2000; 30: 393–9.
21. SEARS MR, BURROWS B, FLANNERY EM, HERBISON GP, HEWITT CJ, HOLDAWAY MD. Relation between airway responsiveness and serum IgE in children with asthma and in apparently normal children. *N Engl J Med* 1991; 325: 1067–71.
22. NORRMAN E, ROSENHALL L, NYSTROM L, JONSSON E, STJERNBERG N. Prevalence of positive skin prick tests, allergic asthma, and rhinoconjunctivitis in teenagers in northern Sweden. *Allergy* 1994; 49: 808–15.
23. LEUNG R, HO P, LAM CWK, LAI CKW. Sensitization to inhaled allergens as a risk factor for asthma and allergic diseases in Chinese population. *J All Clin Immunol* 1997; 99: 594–9.
24. ARSHAD SH, TARIQ SM, MATTHEWS S, HAKIM E. Sensitization to common allergens and its association with allergic disorders at age 4 years: a whole population birth cohort study. *Pediatrics* 2001; 108: e33.
25. MATINEZ FD. Viruses and atopic sensitization in the first years of live. *Am J Respir Crit Care Med* 2000; 162: S95–9.
26. NELSON HS. The importance of allergens in the development of asthma and the persistence of symptoms. *J All Clin Immunol* 2000; 105: S628–32.
27. PEAT JK, TOVEY E, MELLIS CM, LEEDER SR, WOOLCOCK AJ. Importance of house dust mite and *Alternaria* allergens in childhood asthma: an epidemiological study in two climatic regions of Australia. *Clin Exp All* 1993; 23: 812–20.
28. LAU S, ILLI S, SOMMERFELD C, et al. Early exposure to house-dust mite and cat allergens and development of childhood asthma; a cohort study. Multicentre Allergy Study Group. *Lancet* 2000; 356: 1392–7.
29. von MUTIUS E. The environment predictors of allergic disease. *J All Clin Immunol* 2000; 105: 9–19.